

Applicant: Matti Hietaniemi  
PCT App. No.: PCT/FI2004/000058

**Remarks**

Claims 20–39 remain pending in the application.

Applicant believes that no new matter has been added by these amendments and that the application, as amended, is ready for examination. Favorable action thereon is respectfully solicited.

Respectfully submitted,



David R.J. Stiennon, Reg. No. 33212  
Attorney for Applicant  
P.O. Box 1667  
Madison, Wisconsin 53701-1667  
(608) 250-4870  
Amdt1.app

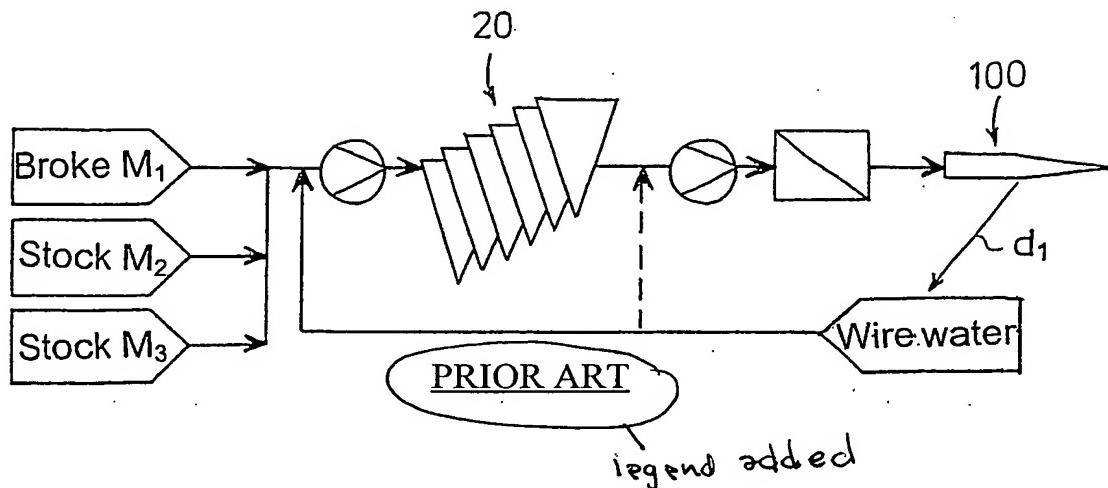


FIG. 1A

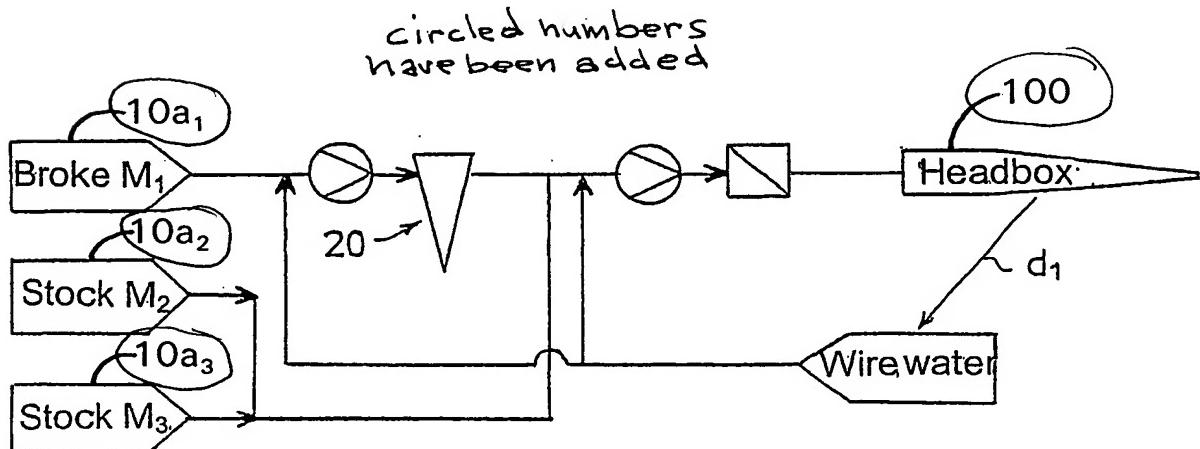


FIG. 1B

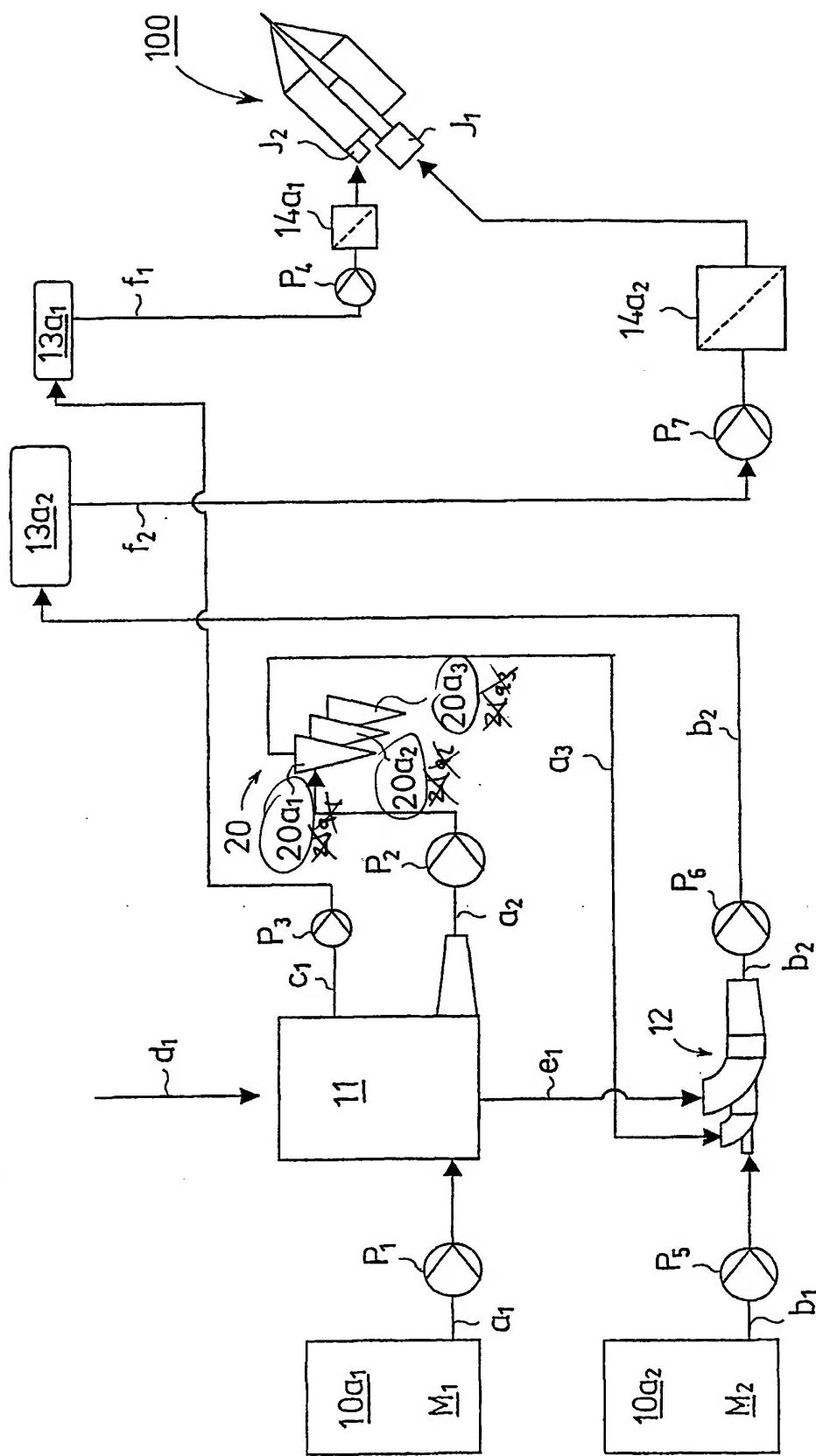


FIG. 2A

10/544898

JC20 Rec'd PCT/PTO 08 AUG 2005

In The United States Patent And Trademark Office

Applicant: Matti Hietaniemi

Date: August 8, 2005

Date Filed: Simultaneously herewith

Docket No.: METSO-45

PCT App. No.: PCT/FI2004/000058

For: Apparatus and Method in the Treatment of the Stock Passed to a Headbox of a Paper Machine or Equivalent

**Certificate of Express Mailing**

I hereby certify that this document is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 35 C.F.R. §1.10

on August 8, 2005

with Mailing Label No. EV 728 023 805 US  
and is addressed to the Commissioner for Patents, P.O. Box  
1450, Alexandria, VA 22313-1450

David R.J. Stiennon

Signature

David R.J. Stiennon, Reg. No. 33212

Name of applicant, assignee or Registered Representative

**Marked Up Copy of Substitute Specification under 37 C.F.R. 1.125(b)(2)**

**TITLE OF THE INVENTION**

Apparatus and ~~in~~Method in the ~~for~~Treatment of  
the ~~the~~Stock ~~is~~Passed to a ~~the~~Headbox of  
a ~~the~~Paper ~~in~~Machine or ~~an~~Equivalent

**CROSS REFERENCES TO RELATED APPLICATIONS**

[0001] This application is a U.S. national stage application of international app. No. PCT/FI2004/000058, filed Feb. 5, 2004, the disclosure of which is incorporated by reference herein, and claims priority on Finnish App. No. 5 20030205, Filed Feb. 11, 2003.

**STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER  
FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT**

**[0002] Not applicable.**

## BACKGROUND OF THE INVENTION

[0003] The invention relates to an apparatus and a method in the treatment of the stock passed to a headbox of a paper machine or equivalent.

[0004] Centrifugal cleaning is needed in paper machines for separation of sand and 5 contaminants. With today's technology, the cleaning efficiency of centrifugal cleaning deteriorates when the ~~ffibre}fiber~~ consistency of the pulp suspension exceeds 1 ~~%}percent~~. This limits the increasing of the feed consistency of the stock to be fed to the headbox. In practice, the slotted screen technique has made it unnecessary to use centrifugal cleaning for separating reject ~~fibres}fibers~~, such as shives. A hydrocyclone plant is placed in the short circulation of the paper machine, where the flow rates are high, as high as 2000 l/s. To be operative, centrifugal 10 cleaning requires a pressure difference of 120~~-~~150 kPa. In that connection, all (about 5) steps of the hydrocyclone plant require pumps, which represent as much as about 25 ~~%}percent~~ of the energy consumption of the short circulation. At a flow 15 rate of 2000 l/s, the power consumption of centrifugal cleaning is about 1200 kW. A typical amount of ~~ffibre}fiber~~ reject from centrifugal cleaning is about 0.1~~-~~0.2 ~~%}percent~~ of production. The loss of the filler pigments coming with coated broke is at its worst about 0.5 ~~%}percent~~ of machine production.

[0005] A filler recovery system is often incorporated in connection with the 20 centrifugal cleaning of the short circulation. In addition to filler, the system must also process other rejects, such as ~~ffibre}fiber~~ reject and sand, coming from the short circulation. In that case, the efficiency of the filler recovery system is not best possible.

[0006] Concepts are known in which the cleaning of the stock has been transferred 25 from the short circulation to pulp lines. The consistency (about 3 ~~%}percent~~) of the broke system is, however, not suitable for separation of sand with hydrocyclones.

**[0007]** When centrifugal cleaning is in the pulp line (e.g. chemical pulp, DIP or TMP), these pulps need not be cleaned again any more, but the debris, sand and ~~{non-disintegrating}~~non-disintegrating coating sheets of paper coming to the broke system via pulpers should be treated by means of hydrocyclones.

5

†

†

## SUMMARY OF THE INVENTION

- [0008] By placing a hydrocyclone plant in accordance with the invention in a broke system line in the short circulation, the problem is solved. The ~~fibre~~fiber consistency in the headbox can be increased, when needed, to a level of over 2 5 ~~%~~percent without the ~~fibre~~fiber consistency in the centrifugal cleaning exceeding the limit of 1 ~~%~~percent.
- [0009] The size and the energy consumption of the hydrocyclone plant would be only about one third of the present size and energy consumption. The size is determined based on the maximal broke percentage.
- 10 [0010] At the same time, better selectivity is achieved in the filler recovery process.
- [0011] In the invention, a hydrocyclone plant is placed in a stock line which is in the short circulation and uses broke, and it is connected with another stock line, so that the bulk of the stock flow (the purer stock) bypasses centrifugal cleaning.
- 15 [0012] The proposal reduces the energy consumption of centrifugal cleaning by about 65 ~~%~~percent, which means a saving of about 17 ~~%~~percent in the energy need of the short circulation. On a large machine the saved power is about 800 kW.
- 20 [0013] The amount of reject from centrifugal cleaning is reduced to a fraction, which means that the amount of reject from centrifugal cleaning would be in its entirety less than 0.05 ~~%~~percent of production. In practice, it could halve the amount of reject in the area of the paper mill, thus reducing the handling capacity 25 associated with ~~fibre~~fiber recovery.
- [0014] The investment in equipment is reduced by about 65 ~~%~~percent in centrifugal cleaning and by about 10 ~~%~~percent in respect of the short circulation. A hydrocyclone plant is a subprocess that takes up much space. By means of the

arrangement in accordance with the invention, the paper machine hall is shortened by 3 m, with the result that the saving in building costs is considerable.

5        **[0015]** In accordance with the invention, a system is formed that includes at least two stock chests. The first stock chest comprises a stock composition  $M_1$  containing pulp that requires centrifugal cleaning before it is passed to the headbox of the paper machine. The stock composition  $M_1$  contains broke pulp passed from the paper machine and, in addition, it can contain pulp coming from ~~fiber~~ fiber recovery and further mechanical pulp. The second stock chest comprises a stock composition  $M_2$  containing pulp that has already undergone centrifugal cleaning, such as recycled  
10      ~~fiber~~ fiber and/or chemical pulp and/or TMP. Thus, it does not contain any broke coming from the paper machine. In the arrangement in accordance with the invention, only the stock  $M_1$  of the first stock chest is treated in the hydrocyclone plant and at least one accept is passed from it into connection with a second stock chest line and its stock  $M_2$ . There can be more stock chests than two.

15      **[0016]** The apparatus in accordance with the invention thus includes a hydrocyclone plant that is much cheaper in capital expenditure and takes up less space than that of the prior art because its capacity need not be as high as that of the prior art arrangements in which all stock is passed through a hydrocyclone plant. In the arrangement in accordance with the invention, it is only the stock  $M_1$ , which has come as broke that is passed through the hydrocyclone plant in the short circulation of the headbox.  
20

~~†The apparatus and the method in the treatment of the stock passed to the headbox of a paper machine or equivalent in accordance with the invention is characterized by what is stated in the claims. [0017] †~~

25      † In the following, the invention will be described with reference to some advantageous embodiments of the invention shown in the figures of the appended drawings, but the invention is not meant to be exclusively limited to them.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0018] Figure 1A shows a prior art apparatus for passing stock to a headbox of a paper machine.

[0019] Figure 1B shows an arrangement in accordance with the invention.

5 [0020] Figure 2A shows a first embodiment of the invention in which broke-containing stock is passed from a first stock chest to a hydrocyclone plant, and in which embodiment the stock is passed through a wire pit.

[0021] Figure 2B shows a second embodiment of the invention.

10 [0022] Figure 3 is an illustration of principle of the operation of a hydrocyclone plant.

## **DESCRIPTION OF THE PREFERRED EMBODIMENTS**

[0023] Fig. 1A shows a prior art stock system in which all stock  $M_1 + M_2 + M_3$  is passed to a hydrocyclone plant 20, which means that a high capacity is required from the hydrocyclone plant.

5 [0024] Fig. 1B shows an arrangement in accordance with the invention. A stock chest 10a<sub>1</sub> contains stock, i.e. a pulp fraction  $M_1$ , which contains broke passed from a paper machine and said pulp fraction  $M_1$  is treated in a hydrocyclone plant 20. The cleaned stock, its accept is passed further into connection with stocks  $M_2$  and  $M_3$ , that do not contain broke and further to a headbox 100. The pulp fractions  $M_2$  and  
10  $M_3$ , that do not contain broke in stock chests 10a<sub>2</sub> and 10a<sub>3</sub> thus bypass the centrifugal cleaning 20, and the accept of the stock  $M_1$  from the hydrocyclone plant 20 is passed into connection with said stocks  $M_2$  and  $M_3$ . The hydrocyclone plant 20 is not required to have as high a capacity as that of the embodiment of Fig. 1A.

15 [0025] In the embodiment of Fig. 2A, stock  $M_1$ , or a pulp fraction, of a first stock chest 10a<sub>1</sub> also comprises a stock composition that requires centrifugal cleaning before it is passed to a headbox of a paper machine. The stock  $M_1$  contains broke coming from the paper machine and, in addition, it may contain pulp coming from  
15 ~~fibre~~fiber recovery, and further mechanical pulp.

20 [0026] Stock  $M_2$  of a second stock chest 10a<sub>2</sub> comprises a stock composition that has already undergone centrifugal cleaning, such as recycled ~~fibre~~fiber and/or chemical pulp and/or TMP.

25 [0027] In the embodiment of Fig. 2A, the stock  $M_1$  is passed from the stock chest 10a<sub>1</sub> through a stock line a<sub>1</sub> to a lower part of a wire pit 11. The line a<sub>1</sub> includes a pump P<sub>1</sub>. In the lower part of the wire pit, the stock  $M_1$  is diluted with wire water obtained from a wire section of a paper machine (not shown) along a line d<sub>1</sub> to a consistency required by a hydrocyclone plant 20. A line a<sub>2</sub> leads from the lower part of the wire pit 11 to the suction side of a pump P<sub>2</sub> and a line a<sub>2</sub> leads from the

pressure side of the pump  $P_2$  to a first centrifugal cleaning step  $20a_1$  of the hydrocyclone plant 20 situated in the short circulation of the paper machine. In the figure, the centrifugal cleaning steps are designated with  $20a_1$ ,  $20a_2$ ,  $20a_3$ ... An accept line from the centrifugal cleaning step  $20a_1$  of the hydrocyclone plant 20; a line  $a_3$  is passed further to join a line  $b_1$  of the stock  $M_2$  of the second stock chest  $10a_2$  via a mixing device 12. The mixing device 12 is also supplied with wire water from the wire pit 11 along a line  $e_1$  for diluting the stock  $M_2$  to be fed to the headbox 100 to a suitable consistency.

[0028] From the upper part of the wire pit 11 there is further a line  $c_1$  for dilution water, said line  $c_1$  including a pump  $P_3$ . The line  $c_1$  leads further from the discharge side of the pump  $P_3$  to a deaeration tank  $13a_1$ . The dilution water passed through the deaeration tank  $13a_1$  is conducted further after the deaeration treatment to a discharge line  $f_1$  and further while pumped by a pump  $P_4$  to a machine screen  $14a_1$ , whose accepted fraction, i.e. accept, is passed to a dilution inlet header  $J_2$  in the headbox 100.

[0029] The stock chest  $10a_2$  is provided with the line  $b_1$  for the stock and further to the suction side of a pump  $P_5$ . On the discharge side of the pump  $P_5$ , the line  $b_1$  is connected to the mixing device 12, after which there is a pump  $P_6$  in a line  $b_2$  for pumping the combined stock further along the line  $b_2$  to a deaeration tank  $13a_2$ , from which a discharge line  $f_2$  leads further to the suction side of a pump  $P_7$ . On the discharge side of the pump  $P_7$ , in the line  $f_2$  there is a machine screen  $14a_2$ , from which an accepted fraction, i.e. accept, is passed to a stock inlet header  $J_1$  of the headbox 100.

[0030] In the device arrangement in accordance with the invention, only the broke-containing stock  $M_1$  passed from the stock chest  $10a_1$  is treated in the hydrocyclone plant 20. An accept line  $a_3$  leads from said hydrocyclone plant further into connection with the stock line  $b_1$  of the stock  $M_2$  of the second stock chest  $10a_2$ . Since the stock  $M_2$  of the second stock chest  $10a_2$  comprises stock that has already

previously undergone centrifugal cleaning, said line can be connected directly to the headbox 100 of the paper machine, via its deaeration tank 13a<sub>2</sub> and machine screen 14a<sub>2</sub>.

5 [0031] In the embodiment of Fig. 2B, stock M<sub>1</sub>, i.e. a pulp fraction, of a first stock chest 10a<sub>1</sub> also comprises a stock composition that requires centrifugal cleaning before it is passed to a headbox of a paper machine. The stock M<sub>1</sub> contains broke coming from the paper machine and it can additionally contain pulp coming from ~~fibre~~fiber recovery and further mechanical pulp.

10 [0032] Stock M<sub>2</sub> of a second stock chest 10a<sub>2</sub> comprises pulp that has already undergone centrifugal cleaning, such as recycled ~~fibre~~fiber and/or chemical pulp and/or TMP.

15 [0033] Also in this embodiment of the invention, only the stock M<sub>1</sub> passed from the stock chest 10a<sub>1</sub> is treated in a hydrocyclone plant 20. In the embodiment of the figure, the stock is passed from the stock chest 10a<sub>1</sub> through a line ~~f<sub>1</sub>~~a<sub>1</sub> while pumped by a pump P<sub>10</sub> to a mixing device 120, in which the stock is diluted to a centrifugal cleaning consistency with wire water obtained from a line f<sub>4</sub>, and the stock M<sub>1</sub> is passed further through a line a<sub>2</sub> to the suction side of a pump P<sub>20</sub>. The line a<sub>2</sub> on the pressure side of the pump P<sub>20</sub> is connected to the hydrocyclone plant 20 to form the feed of its first centrifugal cleaning step 20a<sub>1</sub>.

20 [0034] In the embodiment of Fig. 2B, the hydrocyclone plant 20 situated in the short circulation of the paper machine includes centrifugal cleaning steps 20a<sub>1</sub>, 20a<sub>2</sub> and 20a<sub>3</sub>. An accept line a<sub>3</sub> leads further from the first hydrocyclone, i.e. the centrifugal cleaning step 20a<sub>1</sub> of the hydrocyclone plant 20 into connection with a stock line b<sub>1</sub> of a second stock chest 10a<sub>2</sub>.

25 [0035] In the embodiment, wire water from the paper machine is passed to a wire pit 110 through a line d<sub>1</sub>, which wire pit 110 in this embodiment is formed by a

planar wire pit structure, a so-called flume, which comprises a horizontal flow path for wire water. Said wire pit 110 removes effectively air in bubble form from the wire water, and pre-deaeration of the wire water is accomplished by means of said wire pit type. The wire water is passed from the wire pit 110 through a discharge line 5  $d_2$  and a pump  $P_{30}$  to a deaeration tank  $13a_3$ , from which there is further a discharge line  $f_3$  leading into connection with the line  $b_1$  of the stock  $M_2$  of the second stock chest  $10a_2$  via a mixing device 12. The line  $f_4$  leads further from the discharge line  $f_3$  of the deaeration tank  $13a_3$  into connection with the line  $a_1$  of the stock  $M_1$  of the first stock chest  $10a_1$  via the mixing device 120. A branch line  $f_5$  leads further from 10 the line  $f_3$  to a pump  $P_{40}$  and further from the pressure side of the pump  $P_{40}$  to a machine screen  $14a_3$ , which conducts the wire water further as accept from the machine screen  $14a_3$  to a dilution water inlet header  $J_2$  of a headbox 100.

[0036] The stock  $M_2$  is passed from the stock chest  $10a_2$  through a pump  $P_{50}$  along the line  $b_1$  to the mixing device 12 in order to be combined with the stock coming as accept along the line  $a_3$  from the hydrocyclone plant 20 and with the dilution water coming along the line  $f_3$ . After that the diluted stock is pumped by means of a headbox feed pump  $P_{60}$  through a machine screen  $14a_4$  to a stock inlet header  $J_1$  of the headbox 100.

[0037] As shown in Fig. 3, the hydrocyclone plant 20 includes several centrifugal cleaning steps  $20a_1$ ,  $20a_2$ ,  $20a_3$ , so that, as shown in the figure, accept from the first step  $20a_1$  is passed through the line  $a_3$  further into connection with the line  $b_1$  of the stock  $M_2$  of the second chest  $10a_2$ . As shown in Fig. 3, the stock is passed through the line  $a_1$  as a feed to the first centrifugal cleaning step of the hydrocyclone plant 20, i.e. to the hydrocyclone  $20a_1$ . The stock flows along a spiral-shaped path inside the hydrocyclone  $20a_1$  and heavier particles separate as reject from the bottom of the hydrocyclone and lighter particles rise as accept further through the line  $a_3$  into the line  $b_1$  of the stock  $M_2$  passed from the second stock chest  $10a_2$ . There can be several hydrocyclones  $20a_1$ ,  $20a_2$ ,  $20a_3$ ... and the reject from the first hydrocyclone  $20a_1$  can be passed further to the second hydrocyclone  $20a_2$  as its feed and the accept from it

in one embodiment can be passed further to the line  $b_1$  of the stock  $M_2$  of the second stock chest  $10a_2$ .

[0038] The figure shows a headbox 100. The headbox 100 in accordance with the invention is advantageously a so-called dilution headbox, which means that the dilution water passed to the dilution water inlet header  $J_2$  is passed further across the width of the headbox to different points of the stock passed from the stock inlet header  $J_1$ . In this way, dilution makes it possible to regulate the basis weight of the web across the width of the web. The dilution water passed from the dilution water inlet header  $J_2$  is passed to ducts which are provided with dilution water valves, by means of which the supply of dilution water can be regulated as desired across the width of the headbox, thus enabling the basis weight of the web to be regulated to be even across the entire width of the web.

[0039] As shown in the figure, the hydrocyclone plant can also include several accept lines, the stock passed through them being conducted into connection with another stock or with stocks passed from other chests. In accordance with the invention, it is also possible to use several stock chests, but in the invention only that stock, such as the broke-containing stock  $M_1$ , which shall be treated in the hydrocyclone plant is circulated through the hydrocyclone plant 20. The pulp fraction  $M_2$  which need not be cleaned with hydrocyclones is passed directly to deaeration and, after a machine screen, to the stock inlet header  $J_1$  of the headbox 100. The accept derived from the stock  $M_1$  in the centrifugal cleaning 20 is conducted into connection with said stock.

[0040] When the stocks  $M_1$  and  $M_2$  of the chests  $10a_1$ ,  $10a_2$  are referred to in this application, it is also possible to call them a pulp fraction  $M_1$  and a pulp fraction  $M_2$ . In this application, the paper machine is understood to mean paper, board and tissue machines.

[0041] The broke can be formed of paper broke, which can include trimmings or

paper passed to a pulper in connection with web breaks.

[ ]

[0042] The present application refers to lines by which are meant stock lines, pipes, ducts along which stock/wire water is passed. [ ]

**Abstract**

**The invention relates to at ABSTRACT OF THE DISCLOSURE**

An apparatus in the treatment off ~~the~~ stock passed to a headbox of a paper machine or equivalent, ~~in which the apparatus~~ includes at least two stock chests (10a<sub>1</sub>, 10a<sub>2</sub>).

5 Stock (M<sub>1</sub>) from a first stock chest (10a<sub>1</sub>) is passed along a line (a<sub>1</sub>, a<sub>2</sub>) to a hydrococyclone plant (20) in the short circulation of the paper machine or equivalent. An accept line (a<sub>3</sub>) of the hydrocyclone plant is connected with a stock line (b<sub>1</sub>) of the stock (M<sub>2</sub>) fed from a second stock chest (10a<sub>2</sub>), and a combined stock flow is passed along a line (b<sub>2</sub>) to the headbox (100) of the paper machine or equivalent. ~~The invention also relates to at~~ A method in the treatment of the stock passed to a headbox of a paper machine or equivalent is disclosed.